

## **NIBP Module, M-NIBP (Rev. 03)**

All specifications subject to change without notice

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## **INTRODUCTION**

The Non-Invasive Blood Pressure Module, M-NIBP, is a double width module that provides non-invasive blood pressure measurement in the AS/3 monitors.

# I SPECIFICATIONS

## I.1 General Specifications

Module size W x D x H: 75 x 180 x 112 mm  
3.0 x 7.1 x 4.4 in

Module weight: 0.9 kg / 2.0 lbs

Power consumption: about 4 W

## I.2 Typical Performance

Oscillometric measurement principle

Measurement range

adult	25 to 260 mmHg
child	25 to 195 mmHg
infant	15 to 145 mmHg

Accepted HR 30 to 250 bpm

Measurement interval from continuous to 60 min.

Measurement time,	adult	23 s
typical	infant	20 s

Initial inflation pressure

adult	$185 \pm 10$ mmHg
child	$150 \pm 10$ mmHg
infant	$120 \pm 10$ mmHg

Venous stasis

adult	$80 \pm 10$ mmHg / 2 min.
child	$60 \pm 10$ mmHg / 2 min.
infant	$40 \pm 10$ mmHg / 1 min.

Cuff widths

Tall adult	15 cm
Standard adult	12 cm
Small adult	9 cm
Child	6 cm
Infant	5 cm
Infant	3 cm

### 1.3 Technical Specifications

Deflation rate, HR dep. 5 to 13 mmHg/sec

Inflation rate, typical 25 to 35 mmHg/sec  
(20 to 100 mmHg, adult cuff)

Automatic software control, max. inflation pressure:

adult	$280 \pm 10$ mmHg
child	$200 \pm 10$ mmHg
infant	$150 \pm 10$ mmHg

Over pressure limit, stops measurement after 2 seconds:

adult	320 mmHg
child	220 mmHg
infant	165 mmHg

Mechanical safety valve limits the maximum cuff pressure to 330 mmHg. Independent timing circuit limits pressurizing (>15 mmHg) time to 2 minutes maximum in adult/child mode, and 1 minute in infant mode.

Zeroing to ambient pressure is done automatically.

Inflation pressure is adjusted according to the previous systolic pressure, typically 40 mmHg above. If the systolic pressure is not found, inflation pressure is increased typically 50 mmHg.

Max. measurement time:

adult	2 min.
child	2 min.
infant	1 min.

Pressure transducer accuracy is better than  $\pm 3$  mmHg or  $\pm 2\%$  (whichever is greater). Max. error  $\pm 4$  mmHg.

Protection against electrical shock	Type BF defibrillation proof
-------------------------------------	------------------------------

## **2 FUNCTIONAL DESCRIPTION**

### **2.1 Measuring principle**

NIBP (Non-Invasive-Blood-Pressure) is an indirect method for measuring blood pressure.

The NIBP measurement uses the oscillometric measuring principle. The cuff is inflated with a pressure slightly higher than the presumed systolic pressure, then deflated at a speed based on the patient's heart rate, collecting data from the oscillations caused by the pulsating artery. Based on these oscillations, the module calculates values for systolic, mean, and diastolic pressures.

The NIBP measuring module is a fully automatic, self-contained non-invasive blood pressure measuring system which communicates with the main CPU via an asynchronous RS-485 serial channel. All NIBP functions are controlled by the NIBP's CPU in the NIBP board.

The following parts are necessary for NIBP measurement:

- NIBP module
- Twin hose (Adult or Infant model)
- Blood pressure cuffs (different sizes)



## 2.2 Main Components

### In general

The NIBP module contains the following main parts:

- NIBP board
- Pneumatics and hosing
- NIBP air pump
- Safety (Over pressure) valve
- Check valve
- Bleed valve
- Exhaust valves (2)
- Pressure transducers (2)
- Module keyboard and status indicator LEDs

Most of the electronic components inside the NIBP module, such as microprocessor, software, and pressure transducers, are on PC board. Pneumatic valves and pump are placed inside the module body.

All connections are established via 25-pin connector (D-type, female). The module needs +5 V, +15 V, and -15 V power supply to operate. The pump and the valves use separate +15 VD (dirty) power line. The supply voltages are generated in the power supply section of the AS/3 Monitor.

Communication between the module and the monitor CPU board is established through RS485 serial interface at 500 kbit/s data transfer rate.

### 2.2.1 NIBP Board

#### Pressure transducer

The module contains two pressure transducers. They are of piezoresistive type. One is used for measuring the pressure of the blood pressure cuff and the pressure fluctuations caused by arterial wall movement. The other is used as a second source to measure the pressure of the cuff. This measured value is not used for the actual blood pressure calculation, but for detection of cuff hose type, cuff loose and cuff occlusion situations etc.

The transducers are internally temperature compensated. They are supplied by a constant voltage and their output voltage changes up to 40 mV max. (50 kPa, 375 mmHg).

### **Signal processing**

Two signals from the pressure transducers are amplified and sent to A/D converter. After the converter, digitized signals are sent to microprocessor for data processing. Before the converter, one of the signals is used to adjust the offset to the pressure safety level.

The NIBP module is controlled with 80C51FA microprocessor which uses 16 MHz oscillator frequency.

### **Memory**

NIBP program memory (EPROM) size is 128k x 8. RAM size is 32k x 8 bit and it stores variable values in NIBP measurement. EEPROM is size 64 x 16 bit and is used to store the calibration values for the pressure transducers, the pulse valve constants gained during measurements, the PC board identification, and module serial number.

### **Control**

Software controls valves, pump and LEDs. In addition to the individual on/off signals for each component there is a common power switch for the valves and the pump that can be used at pump/valve failures.

In addition to external RS485 reset line the microprocessor system is equipped with its own power-up reset.

### **Safety circuit**

The NIBP module is equipped with software independent safety circuit to disconnect supply voltages from the pump and the valves if the cuff has been pressurized longer than preset time. Pressure limit is specified to 15 mmHg. As soon as the cuff pressure rises over 15 mmHg, timer starts counting. The timer is adjusted to stop the pump and open the valves in 2 minutes 10 seconds in adult/child mode and in 1 minute 5 seconds in infant mode.

### **Pressure safety level check**

Pressure safety level detection is checked in Service Menu. When pressure (generated by external pump with manometer) inside module exceeds safety level (adjusted to 14 mmHg) the sign of the signal at AD5 on the NIBP Menu/Pneumatics Service Menu changes from negative to positive value. If the change doesn't occur within  $14 \pm 5$  mmHg, adjust it (see the Chapter 4.3).

### **NIBP tubing lengths**

There are two different tubes inside the module. They are silicon tubes  $1.7 \times 1$  (part number 73373) and  $3.18 \times 6.35$  (73375). When ordering, specify the part number and length(s) required.

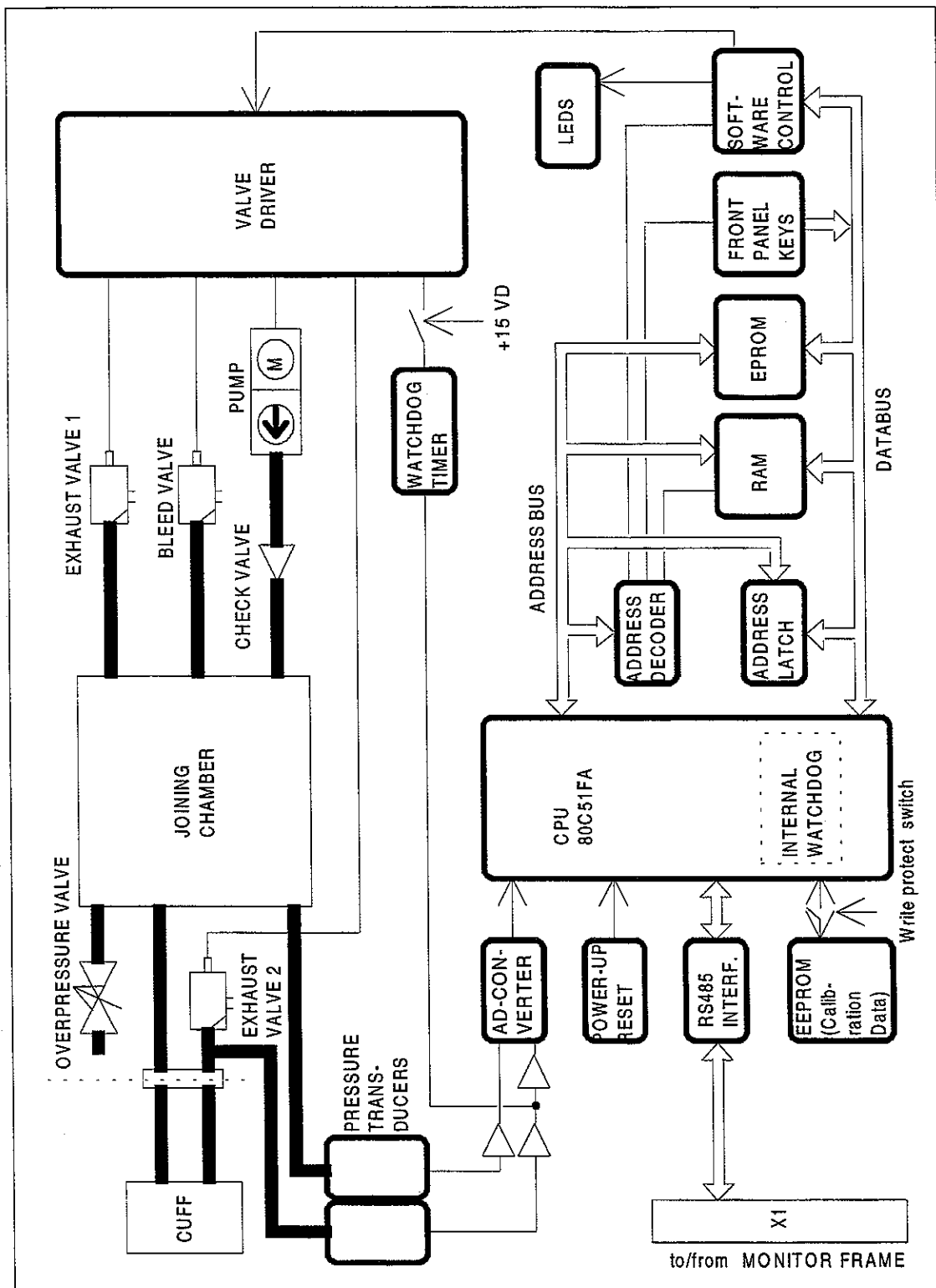


Figure 1 M-NIBP Functional Block Diagram

## 2.3 Module Bus Connector Configuration

Module rear panel 25-pin female D-connector (X1)

Pin No	I/O	Signal
1	I	RESET_RS485*
2	I	-15 VDC
3	I	+15 VDIRTY*
4	I	+15 VDC
5	I/O	-DATA_RS485*
6	I/O	DATA_RS485*
7	-	Ground & Shield*
8	I	-RESET_RS485*
9	I	CTSB
10	O	RTSB
11	I	RXDB
12	O	TXDB
13	-	Ground & Shield*
14	I	+32 VDIRTY
15	I	GroundDIRTY*
16	I	CTSC
17	O	RTSC
18	I	RXDC
19	O	TXDC
20	-	ON/STANDBY
21	-	BIT0IN
22	-	RXDD_RS232
23	-	TXDD_RS232
24	I	+5 VDC*
25	I	+5 VDC*

\* Used in NIBP module

## **3 SERVICE PROCEDURES**

### **3.1 General Service Information**

Field service of the NIBP module is limited to replacing the faulty circuit boards or mechanical parts. Return the boards to Datex for repair.

Datex is always available for service advice. Please provide the unit serial number, full type designation, and a detailed fault description.

**CAUTION:** Only trained personnel with the appropriate tools and equipment shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

## 3.2 Preventive Maintenance Checks

Perform these checks after any service and at least once a year to keep the AS/3 Anaesthesia Monitor NIBP Module in good condition.

### 1. Visual inspection

- \_\_\_: If the module is disassembled, check that grounding wires and all connectors are properly connected and there is no loose object inside the module. Check also that tubes are not pinched and there is no sharp bend before attaching the module box.

### 2. Functional checks

- \_\_\_: Go to Service Menu, NIBP module, and Buttons/LEDs test. Check that all the LEDs can be lit and the keys operate normally.
- \_\_\_: Connect a manometer to the NIBP connector. Go to Service Menu, NIBP module, Calibrations, and choose Active leak test. The module automatically pumps a pressure of about 265 mmHg and the pump stops. Wait for 15 seconds for the pressure to stabilize. Then check that the pressure does not go down more than 5 mmHg per minute. Release the pressure.
- \_\_\_: Go to Service Menu, NIBP module, Calibrations, and Calibration check. Check first zero offsets (z.o.) of both channels, B1 and B2, and write down the values when NIBP connector is open to ambient air. The values should be within  $\pm 10$  mmHg.

Connect the manometer to the connector. Check the following pressures.

Manometer display	Allowed values on display
100 mmHg	$100 + \text{z.o.} \pm 2 \text{ mmHg}$
200 mmHg	$200 + \text{z.o.} \pm 3 \text{ mmHg}$
260 mmHg	$260 + \text{z.o.} \pm 4 \text{ mmHg}$

Calibrate if not within specification:

- \_\_\_: Go to Service Menu, NIBP module, and Watchdogs. Perform both Adult and Infant watchdog time tests.
- \_\_\_: Go to Service Menu, NIBP module, and Pneumatics. Pump reference pressure (14 mmHg) slowly to the chamber. Check that the value at AD5 toggles from negative to positive value at 14 mmHg  $\pm$  5 mmHg. A beep sounds to indicate when the pressure crosses this level.
- \_\_\_: **NOTE:** Make sure the manometer you are using can be used to measure pressures over 300 mmHg.

Go to Service Menu, NIBP module, Pneumatics, and Start pump. The opening pressure of Safety valve is displayed at B1 and B2. It should be between 280 and 330 mmHg. Repeat the test for more accurate result.

- \_\_\_: Go to Service Menu, NIBP module, Pneumatics, and Start pump. Let the pressure rise over 250 mmHg then stop the pump. Select Open exh1 and observe the pressure drops to zero within 10 seconds. Select close exh1. Repeat the procedure and select Open exh2. The pressure should drop to zero within 10 seconds.
- \_\_\_: Connect a normal adult cuff to the connector and wrap it around a pipe. Select VENOUS STASIS ON and start the test. The cuff holds a pressure of 70 to 85 mmHg for two minutes and the pump does not start within that time.
- \_\_\_: Wrap the cuff around your arm. Make one measurement. Check that the message ADULT appears at start of the measurement for about 5 seconds in NIBP field on the display. Check that the measurement result also appears.
- \_\_\_: If an Infant cuff hose (white) is available, connect it and the infant cuff and wrap the cuff around a pipe. Check in NIBP Setup Menu that the inflation limit is set to Auto. Start a measurement and check that the message INFANT appears at start of the measurement for about 5 seconds in NIBP field on the display.



### **3.3 Disassembly and Reassembly**

Disassemble the NIBP module in the following way. See the exploded view of the module:

- a) Remove the two screws from the back of the module.
- b) Pull the module box slowly rearward and detach it from main body. Be careful with loose latch and spring pin for locking.
- c) Remove the four corner screws from the back of NIBP board. The NIBP board and the front panel can be detached.
- d) To free the front panel and the NIBP board, disconnect tubes and connectors.
- e) Remove the five screws and lift off the plastic pump cover. NIBP pump, safety (over pressure) valve, and valve unit which includes two valves, wires and a connector will be exposed. Remove them.
- f) Pull out pulse valve from the bottom of the NIBP frame.
- g) Reassemble by reversing what was described above.

**CAUTION:** Before reattaching the module box, make sure that the tubes are not pinched between the NIBP frame and the PC board.

**NOTE:** Take care that the connectors and especially the tubes are reconnected properly and to the right ports.

## 3.4 Adjustments and Calibrations

### Adjustment

#### Pressure safety level detection "OFFSET"

Remove two screws at the rear of the module. Take the module box away. Connect first the service cable (e.g. a long Gas Interface Cable) to the module connector inside the monitor frame and then to the rear connector of the module. Go to the NIBP Service Menu and select "Pneumatics". Pump reference pressure (14 mmHg) into the module. Adjust the trimmer R12 so that AD5 signal sign changes from negative to positive at 14 mmHg.

### Calibrations

#### Pressure measurement calibration

The electronics of NIBP pressure measurement is calibrated at the factory. Pressure zero is automatically maintained by the processor. If the zero point of the pressure transducer drifts more than specified, an error message is given and the NIBP board needs to be recalibrated or replaced.

The calibration can be checked and, when necessary, recalibrated in the NIBP Service Menu.

The calibration of the primary pressure channel can also be checked in NIBP Set-up menu by selecting NIBP, NIBP Setup, and Calibration Check. In this case the auto zeroing is performed at start - remove hose before entering to ensure atmospheric pressure to the pressure transducers - the primary pressure is displayed. The zero-offset value should then be zero.

#### 1. Calibration check

For how to reach the Calibration menu, see chapter 5, Service Menu.

1. Enter Calibration menu.

### Calibration

Active Leak Test
OFF

Calibration Check
OFF

Protection
OFF

Calibration

Previous Menu

2. Select "Calibration Check" and press the ComWheel.
3. Connect external precision manometer to the module.
4. Pump the following pressures to manometer and check the difference between the manometer and monitor pressure display:

Pressure	Max. error	Example
0 mmHg	$\pm 9$ mmHg (=zero offset)	-2
100 mmHg	100 + zero offset $\pm 2$ mmHg	$98 \pm 2$
200 mmHg	200 + zero offset $\pm 3$ mmHg	$198 \pm 2$

If the error of pressure channel B1 is larger than specified above, the module needs to be re calibrated. The error of B2 is allowed to be even twice as large because it has no effect on blood pressure measurement accuracy. However, it is recommended to re calibrate the module also when the error of B2 is larger than specified above to ensure best possible operation.

## **2. Calibration**

For how to reach the Calibration menu, see chapter 5, Service Menu.

1. Enter "Calibration" in NIBP Service Menu.
2. Remove hoses from front panel connector to enable proper zeroing.
3. Select "Calibration". If it is not available, perform the steps A,B, and C.

**NOTE: Do not pull off the NIBP module from the monitor frame. The module must be in the frame during the whole procedure.**

- A. Turn the toggle switch at the bottom of the NIBP module to enable the calibration. Turn the switch to the right by, for example, a sharp pencil. This enables menu selection "Protection". the message "Calibration switch ON!" appears.
  - B. Select Protection OFF in the Calibration menu and push the ComWheel.
  - C. Return the toggle switch to the left. Menu selection "Calibration" is now enabled, and "Protection" is disabled. When the calibration is enabled, a message "Calibration not protected" appears.
3. Start Calibration by pushing the ComWheel. Messages "ZEROING" and "ZEROED" will appear in the NIBP message field. After this a pressure bar will appear.
  4. Connect an external mercury manometer with pump to module through the both tubes of the hose - both transducers B1 and B2 must be calibrated simultaneously. Pump up to a pressure about 200 mmHg according to the manometer. Calibration is possible in the range 150 to 300 mmHg.
  5. Verify that both pressure values in the prompt field match the manometer reading. If not, adjust by turning

the ComWheel. When the values of the pressure bar and the manometer are equal, press the ComWheel to confirm the calibration. The message "Calibrating" will appear onto the NIBP digit field. After a few seconds it is followed by "Calibrated", which means that the calibration has succeeded, and the new calibration data has been saved into EEPROM.

To set the protection on:

Turn the toggle switch to the right. Select "Protection" ON and push the ComWheel. Then turn the toggle switch back to the left.

6. Remove the module from the frame and plug it back again. Then perform Calibration Check (see the preceding page) to verify the new calibration.

## 4 TROUBLESHOOTING

### 4.1 Module Troubleshooting

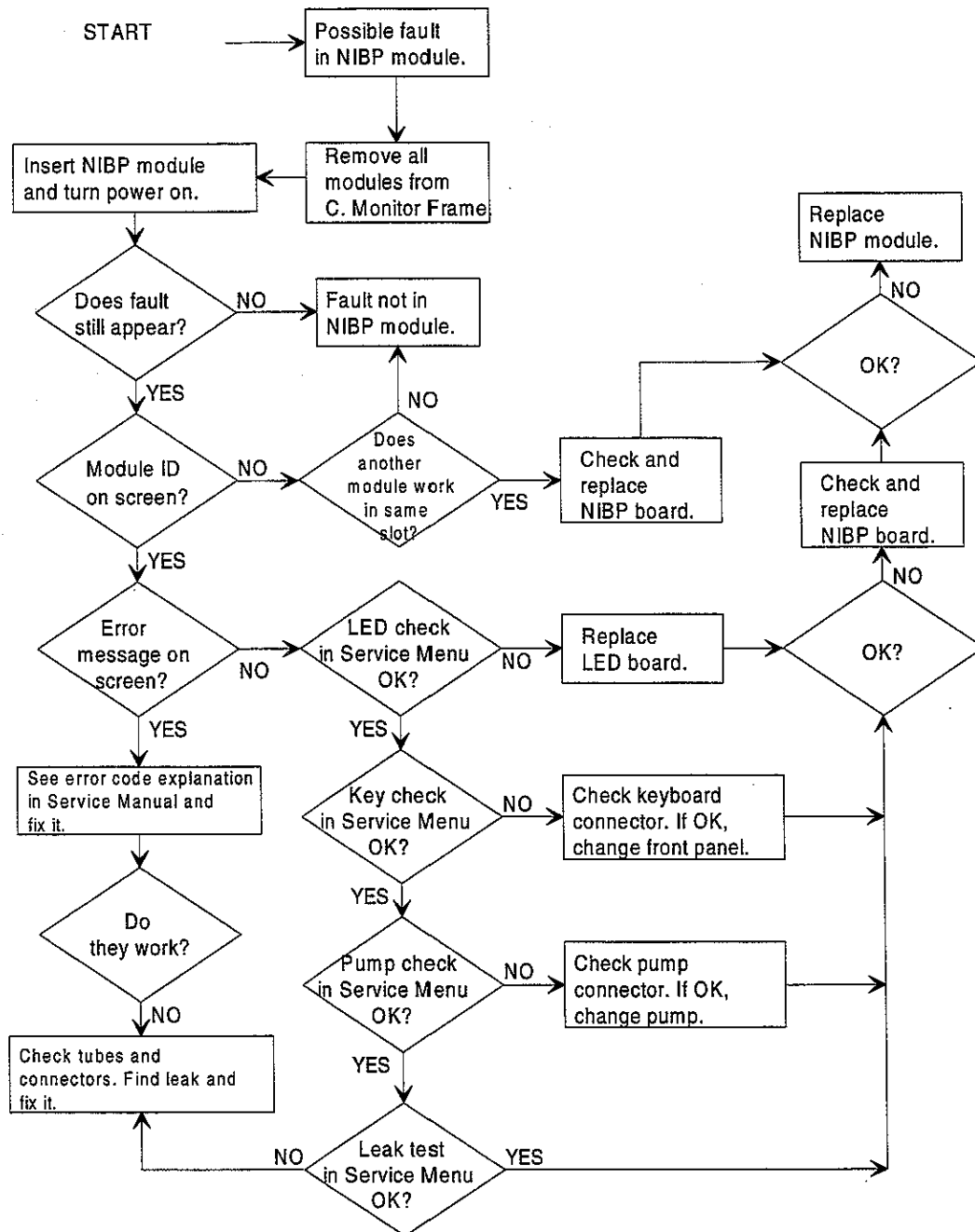


Figure 2 NIBP Module Troubleshooting Flow Chart

## 4.2 Troubleshooting Chart

TROUBLE	CAUSE	TREATMENT
No NIBP value displayed	Not selected on screen.	Press Monitor Setup key and select MODIFY NUMBERS.
NIBP menu fading	No NIBP module or module not properly connected.	Plug in the module.
Artifacts-message	Unsuccessful measurement due to patient movements or shivering.	
Weak pulsation-message	Weak or unstable oscillation pulses due to: - artifacts (accurate diastolic pressure difficult to measure). - marked arrhythmia. - marked drop in diastolic pressure. - diastolic pressure difficult to measure. - improper cuff position or attachment. - too few pulses detected. - weak or unusual blood circulation. - may give systolic value.	Check patient condition. Retry.  Check any leaks and retry.  Use proper size cuff. Check attachment.
Call service. Error X-message	NIBP hardware error. X= error number	See the description of the error message codes, their causes and solutions listed in the next chapter.
Cuff loose-message	(a) Hose and/or cuff detached.  (b) Hose and cuff connected. Reason: - cuff loosely wrapped, large volume. - leakage in cuff or hose. - leakage inside module. - pump does not work. - no pulses during the last three measurements.	(a) Connect them.  (b) - tighten the cuff. - replace cuff/hose. - check internal tubing and air chamber, and fix if necessary. - check pump connector. If OK, replace pump. - check cuff positioning.

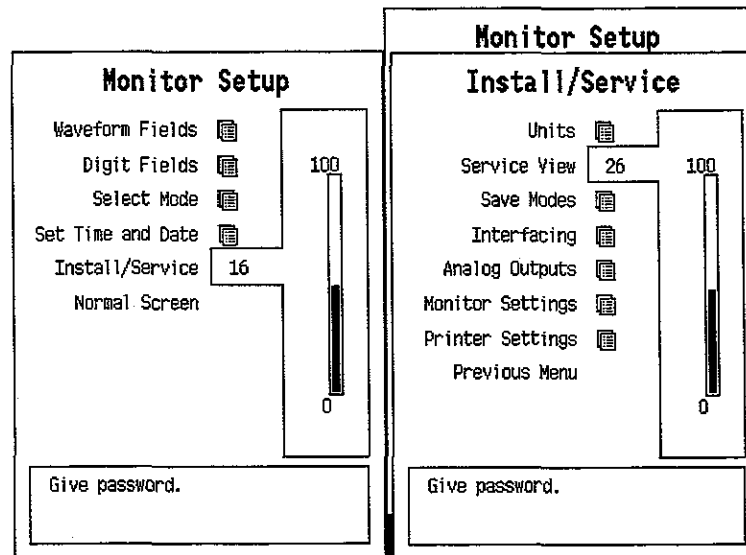
TROUBLE	CAUSE	TREATMENT
Air leakage-message	<p>(a) Hose or cuff leaking. Reason:</p> <ul style="list-style-type: none"> <li>- cuff damaged.</li> <li>- cuff connector damaged.</li> <li>- O-ring damaged or missing</li> <li>- hose double connector damaged. O-ring damaged or missing.</li> </ul> <p>(b) Hose and cuff OK. Reason:</p> <ul style="list-style-type: none"> <li>- leakage inside the module.</li> <li>- tube disconnected or damaged.</li> <li>- air chamber leaking.</li> <li>- tubes disconnected from valve(s) or valve(s) damaged.</li> </ul>	<p>(a) - replace cuff. - replace cuff connector (if the fault is in hose connector, replace hose). - replace O-ring.</p> <p>(b) - connect or replace tube. - replace the whole tubing. - fix connections. Replace valve(s).</p>
Unable to measure Sys-message	Systolic blood pressure probably higher than the maximum inflation pressure.	Automatic retrial with increased pressure.
Cuff occlusion-message	<p>(a) Cuff and/or hose occluded. Reason:</p> <ul style="list-style-type: none"> <li>- cuff tube kinked.</li> <li>- tube inside module kinked.</li> <li>- occlusion inside/outside module.</li> </ul> <p>(b) Cuff, hose, and tubes OK. Reason:</p> <ul style="list-style-type: none"> <li>- fault in pressure transducer.</li> <li>- fault in A/D converter.</li> <li>- faulty calibration.</li> <li>- missing voltages.</li> </ul>	<p>(a) - straighten tube. - remove occlusion.</p> <p>(b) - replace the NIBP board. - check calibration. Re calibrate.</p>
Calibration switch on - message	EEPROM protection switch at the bottom of the module is turned to right.	Enables setting the protection OFF in the Calibration menu. turn switch to left if you are not going to calibrate.
Calibration not protected -message.	Calibration protection is set to OFF.	



### 4.3 Error Code Explanation

CODE	EXPLANATION
0	RAM failure Memory failure. Change NIBP board.
1	ROM checksum error Memory failure. Change NIBP board.
2	+15V failure Check short circuits. Change NIBP board.
3	-15V failure Check short circuits. Change NIBP board.
4	EEPROM protection switch error. (only with S-STD93) Turn the toggle switch to the left at the bottom of the module.
5	Calibration not protected. (only with S-STD93) Protect calibration by selecting Protection ON in the NIBP calibration menu.
6	ADC error ADC circuit failure. Change NIBP board.
7	Watchdog time too short Change NIBP board.
8	Watchdog time too long Change NIBP board.
9	Watchdog activated Change NIBP board.
10	EEPROM checksum error Memory failure. Change NIBP board.
11	Auto zero range exceeded Calibrate NIBP.
12	Communication break Temporal break down of communication from monitor detected. Automatic recovery.







## 5 SERVICE MENU



To enter Service Menu during normal operation:

1. Press the MONITOR SETUP key.  
The Setup menu appears.
2. Turn ComWheel to highlight Install/Service and push.
3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34.  
The Install/Service menu appears.
4. Turn the ComWheel to highlight Service View and push.
5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.
6. Turn the ComWheel to highlight Modules and push.
7. Turn the ComWheel to highlight NIBP module and push.

## 5.1 NIBP Service Menu

NIBP Module	Service Data			
Calibrations 	Pressure	B1	B2	
Safety Valve 	Zero	---	---	
Pulse Valve 			AD0	---
Buttons/Leds 			AD1	---
Pneumatics 			AD2	---
Watchdog 			AD3	---
Previous Menu			AD4	---
	Protect handle	OFF	AD5	---
	Calibr. prot.	OFF	AD6	---
	+15 V power	OFF	AD7	---
	Timeouts	65535	RAM	?
	Bad checksums	65535	ROM	?
	Bad c-s by mod	0	EEPROM	?

1. Calibration functions.
2. Safety Valve functions.
3. Pulse Valve service functions.
4. Buttons/Leds service functions.
5. Pneumatics service functions.
6. Watchdog functions.
7. Return to previous menu.

### SERVICE DATA Detailed Description

**Pressure** shows measured pressure multiplied by 10.

**Zero** shows pressure at auto zeroing multiplied by 10 and changes between +20 and -20 mmHg. Absolute pressure is the sum of **Pressure** and **Zero**.

**Protect handle** indicates hardware protection for EEPROM memory. It should be ON all the time in normal operation. If it is OFF data can not be read from or written to EEPROM, only

the calibration protection can be set or reset by software. It can be turned to OFF by turning the toggle switch to the right at the bottom of the module, which also enables 'Protection ON/OFF' menu selection in the calibration menu.

**Calibr. prot.** shows software calibration protection and should be OFF to enable calibration.

**+15 V power** indicates the condition of the supply voltage +15 Vdirty for the pump and valves. It exists (ON) or not (OFF) depending on service menu function.

**AD0 to AD7** show the values of each eight channels of A/D converter.

**Timeouts** is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry.

**Bad checksums** is a cumulative number that indicates how many times communication from the module to monitor broke down.

**Bad c-s by mod** is a cumulative number that indicates how many communication errors the module has detected.

The AS/3 Monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 50 per second) indicates either serial communication failure, or module not in place. Also other modules can cause communication errors that cause these numbers rise.

**RAM** indicates the state of the external RAM memory.

**ROM** indicates whether the checksum in the EPROM is in accordance with the one the software has calculated.

**EEPROM** indicates if the values stored in the permanent memory are valid.

The state is either **OK**, **Fail** or **?** (module not in place or a communication error).

### **5.1.1 NIBP Calibration Menu**

<b>Calibration</b>	
Active Leak Test	OFF
Calibration Check	OFF
Protection	OFF
Calibration	
Previous Menu	

1. Active leak test selection (ON/OFF)
2. Calibration check selection (ON/OFF)
3. Software calibration protection (ON/OFF). Select OFF when calibrating. Protection can be set to ON or OFF only when the toggle switch at the bottom of the module is set to the right.
4. Calibration. Calibration selection is available only when protection is OFF.
5. Return to previous menu.

### Active Leak Test

Wrap an adult cuff around a pipe and connect the cuff to the module. Select the active leak test (ON). The module automatically pumps a pressure of 260 mmHg into the cuff. Wait for several seconds until the pressure stabilizes. Then check that the pressure reading does not drop more than 5 mmHg per minute. If it does, leaking point(s) should be detected and fixed. Cancel the test by selecting Active leak test OFF.

### Calibration Check

After the calibration check is selected (ON), manually pump pressure into the module and make sure that the same pressure values are shown both on the display and on manometer. Pressure of both pressure channels B1 and B2 are shown. Note that if the display shows +2 mmHg at zero pressure and if you pumped +200 mmHg into the module, the display should show +202 mmHg.

### Calibration

NIBP calibration can be performed in the NIBP Service menu as follows:

**NOTE :** Both channels B1 and B2 must be calibrated simultaneously.

1. If **Protection** is ON change it to OFF by first turning the toggle switch to the right at the bottom of the module, which enables the **Protection** selection. Then turn the toggle switch to the left to enable **Calibration**.

**NOTE :** Do not disconnect the module from the frame when turning the switch. The module must be in the frame during the whole procedure.

**NOTE:** When the switch is at the right, the NIBP field shows an error message "Calibration switch on!".

**NOTE:** When calibration is enabled, a message 'Calibration not protected' appears.

2. For proper zeroing to take place, remove the hose from the front panel connector. Select **Calibration** and push the ComWheel. Messages "ZEROING" and "ZEROED" will appear in the NIBP message field. After this a pressure bar will appear beside the menu.
3. Connect an external mercury manometer with pump to module through the both tubes of the hose. Pump up to about 200 mmHg pressure (range of 150 to 300 mmHg allowed) according to the manometer. Verify that both pressure values in the prompt field match the manometer reading. If not, adjust by turning the ComWheel.
4. When the values are equal, push the ComWheel to confirm the calibration. First the message "Calibrating" will appear followed after a few seconds "Calibrated", which means that the calibration data has now been saved.
5. Use the bottom switch to enable **Protection** setting and set it ON, and finally disable **Protection** setting.

### 5.1.2 NIBP Safety Valve Menu

Safety Valve		Safety Valve Data				
<div>Start Test</div>		B1		B2		
Previous Menu		Pressure		000000		
		Zero		000005		
				AD0 -31		
				AD1 10		
				AD2 -45		
				AD3 1167		
				AD4 0		
		Protect handle		ON	AD5 -1825	
		Calibr. prot.		ON	AD6 53	
		+15 V power		ON	AD7 -1153	
		B1		B2		
Max press		303		302		
2 s after stop		290		289		
Timeouts		0	RAM		OK	
Bad checksums		0	ROM		OK	
Bad c-s by mod		0	EEPROM		OK	

1. **Start test** is for starting and **Stop test** is for stopping the Safety Valve test.
2. Return to previous menu.

**NOTE:** Parameter values in Service Data are for reference only.

#### SAFETY VALVE DATA Detailed Description

See NIBP Service menu in chapter 5.1 for information on general items **Pressure**, **Zero**, **Protect handle**, **Calibr. prot.**, **+15 V power**, **AD0** to **AD7** as well as **Timeouts** etc.

**Max. press** and **2 s after stop** show the measured values at Safety Valve test.

#### Safety Valve Test:

Wrap an adult cuff around a pipe and connect the cuff to the module. Highlight **Start test** and give the ComWheel a push. The test ends automatically or when **Stop test** (appears in place of **Start test**) is pushed.

**Max. press** indicates the pressure at which the safety valve opens and is normally  $315 \pm 15$  mmHg. **2 s after stop** indicates the pressure at 2 seconds after the pump has stopped and is normally  $> 280$  mmHg. If the value is less, check leakage by the active leak test (page 27).



### 5.1.3 NIBP Pulse Valve Menu

Pulse Valve	Pulse Valve Data			
Stop Test	Pressure	B1 001730	B2 001710	
Set Valve	Zero	000000	000000	
Previous Menu				
			AD0	450
			AD1	-378
			AD2	-410
			AD3	1167
			AD4	1
	Protect handle	ON	AD5	1817
	Calibr. prot.	ON	AD6	523
	+15 V power	ON	AD7	-1153
			Pulse Valve	50
			Interval 240 mmHg -> 50 mmHg	3 s
	Timeouts	0	RAM	OK
	Bad checksums	0	ROM	OK
	Bad c-s by mod	0	EEPROM	OK

1. **Start test** is for starting and **Stop test** is for stopping the test.
2. **Set Valve** lets you adjust the opening of the pulse valve.
3. Return to previous menu.

**NOTE:** Parameter values in Service Data are for reference only.

#### PULSE VALVE DATA Detailed Description

See NIBP Service menu in chapter 5.1 for information on general items **Pressure**, **Zero**, **Protect handle**, **Calibr. prot.**, **+15 V power**, **AD0** to **AD7** as well as **Timeouts** etc.

### **Pulse Valve Checking:**

Wrap an adult cuff around a pipe and connect the cuff to the module. Select the **Start test** and push the ComWheel. The pressure rises beyond 240 mmHg and stops. The pulse valve opens. The module counts the time it takes for the pressure to go down from 240 mmHg to 50 mmHg and displays it. The test can be manually stopped by selecting **Stop test**.

The valve can be adjusted between 0 and 255 (0 for fully closed and 255 for fully open). First select Set Valve and push the ComWheel. See the pulse valve value and adjust it by turning the ComWheel. Then push the ComWheel to confirm the value.

The "Interval 240 mmHg -> 50 mmHg" time should be less than 60 seconds when the valve is '50' and less than 10 when fully opened (255). When fully closed (0), the system should be airtight and the pressure does not drop. Depending on an individual, the pulse valve may remain closed up to approx. value 45.

If the measured time deviates much from those above, then the pulse valve or its tubes are faulty.

### 5.1.4 NIBP Buttons/Leds Menu

Buttons/Leds		Buttons/Leds Data			
Auto	ON				
Manual	OFF				
STAT	ON				
Measur.	ON				
Previous Menu					
		Pressure	B1 000000	B2 000000	
		Zero	000000	000000	
				AD0	-31
				AD1	10
				AD2	-45
				AD3	1167
				AD4	0
		Protect handle	ON	AD5	-1825
		Calibr. prot.	ON	AD6	53
		+15 V power	ON	AD7	-1153
		Auto On/Off	OFF	Set Cycle Time	OFF
		STAT On/Off	ON	Start Cancel	OFF
		Timeouts	0	RAM	OK
		Bad checksums	0	ROM	OK
		Bad c-s by mod	0	EEPROM	OK

- 1 to 4. **Auto**, **Manual**, **Stat**, and **Measuring** Led selectors. Select ON and push the ComWheel to light the Led in question.
5. Return to previous menu

**NOTE:** Parameter values in Service Data are for reference only.

### BUTTONS/LEDS DATA Detailed Description

See NIBP Service menu in chapter 5.1 for information on general items **Pressure**, **Zero**, **Protect handle**, **Calibr. prot.**, **+15 V power**, **AD0** to **AD7** as well as **Timeouts** etc.

#### Buttons Checking:

The front panel keys function is confirmed by pressing the key and observing OFF turns to ON at **Auto On/Off**, **Set Cycle Time**, **Stat On/Off**, and **Start Cancel**.

#### LEDS Checking:

The front panel LEDS can be lit by selecting **Auto**, **Manual**, **Stat**, or **Measuring**. ON and pushing the ComWheel.

### 6.1.5 NIBP Pneumatics Menu

Pneumatics		Pneumatics Data			
Stop Pump		Pressure	B1 000570	B2 001320	
Open Exh1		Zero	000000	000000	
Close Exh2				AD0 122	
Set Valve				AD1 -1005	
Reset Clock				AD2 -156	
Previous Menu				AD3 1167	
				AD4 1	
		Protect handle	ON	AD5 1817	
		Calibr. prot.	ON	AD6 381	
		+15 V power	ON	AD7 -1153	
		Pump	ON	Exh1 Valve	CLOSED
				Exh2 Valve	OPEN
				Pulse Valve	41
Interval 20 mmHg -> 185 mmHg 4 s					
		Timeouts	0	RAM	OK
		Bad checksums	0	ROM	OK
		Bad c-s by mod	0	EEPROM	OK

1. **Start pump** and **Stop pump** are for the pump.
2. **Open Exh1** is for opening the exhaust valve 1.
3. **Open Exh2** is for opening the exhaust valve 2.
4. With **Set Valve**, the opening of the pulse valve is adjusted between 0 and 255 (0 for fully closed and 255 for fully open). First push the ComWheel, then turn it to adjust the value on screen and finally push to set the value.
5. **Reset Clock** will zero the time on the display .
6. Return to previous menu

**NOTE:** Parameter values in Service Data are for reference only.

## **PNEUMATICS DATA Detailed Description**

See NIBP Service menu in chapter 5.1 for information on general items **Pressure, Zero, Protect handle, Calibr. prot., +15 V power, AD0 to AD7** as well as **Timeouts etc.**

**Pump, Exh1 Valve, and Exh2 Valve** show their states.

**Pulse Valve** shows how much the valve is opened (0 to 255) during Valve Setting.

### **Interval 20 mmHg -> 185 mmHg Checking:**

Select the **Start pump** at different combinations of the valves open/closed and push the ComWheel. The module counts the time it takes for the pressure to go up from 20 mmHg to 185 mmHg and displays it. When all the valves are closed, the pump should be able to pump the pressure in about 1 to 4 seconds into an adult cuff wrapped around a pipe. The pump does not stop without selecting the **STOP PUMP** by pushing the ComWheel.

### **Watchdog BEEP:**

Connect manometer to the front panel and pump pressure into the module. When the AD5 value changes from negative to positive value (at about 15 to 20 mmHg) a beep is heard. This is the watchdog threshold pressure. Beyond this pressure the watchdog is active and cut pressures at about 2 min. (adult).

## 6.1.6 NIBP Watchdog Menu

Watchdog	Watchdog Data			
Test ADULT	Pressure	B1 000000	B2 000000	
Test INFANT	Zero	000000	000000	
Stop Test			AD0	-31
Previous Menu			AD1	10
			AD2	-44
			AD3	1167
			AD4	515
	Protect handle	ON	AD5	-1825
	Calibr. prot.	ON	AD6	53
	+15 V power	OFF	AD7	-1153
	Watchdog Interval 131 s			
	Timeouts	0	RAM	OK
	Bad checksums	0	ROM	OK
	Bad c-s by mod	0	EEPROM	OK

1. **Test ADULT** is to test watchdog timer in adult mode (120 to 140 seconds).
2. **Test INFANT** is to test watchdog timer in infant mode (about 60 to 70 seconds).
3. **Stop Test** is for stopping the test.
4. Return to previous menu

**NOTE:** Parameter values in Service Data are for reference only.

### WATCHDOG DATA Detailed Description

See NIBP Service menu in chapter 5.1 for information on general items **Pressure**, **Zero**, **Protect handle**, **Calibr. prot.**, **+15 V power**, **AD0** to **AD7** as well as **Timeouts** etc.

**Watchdog Interval** shows the time the +15 Vdirty stays on during the test.

#### Adult watchdog time testing:

Select **Test ADULT** and push the ComWheel. Watchdog interval starts counting up seconds and keeps on counting as long as the +15 Vdirty is on. The time should be 120 to 140 seconds.

**Infant watchdog time testing:**

Select Test INFANT and push the ComWheel. Watchdog interval starts counting up seconds and keeps on counting as long as the +15 Vdirty is on. The time should be 60 to 70 seconds.

## 6.1 Spare Part List

**NOTE:** Accessories are listed in the booklet AS/3 Supplies and Accessories.

## NIBP Module, M-NIBP

<u>Item</u>	<u>Item description</u>	<u>Order No.</u>
8	NIBP board, M-NIBP (Rev. 01)	*(880359) Use 883011 1) 883902
11	NIBP frame, M-NIBP	880427
15	Plastic pump cover, M-NIBP	879176
14	NIBP pump, M-NIBP (Rev. 01-02)	*(880363) Use 883346
22	Pulse valve	*880365
21	Magnetic valve	*58534
20	Port plug for magnetic valve	58535
13	Safety valve (overpressure valve)	877109
4	Front panel unit, M-NIBP	881335
	Membrane keypad	879374
16	Front panel sticker, M-NIBP (Eng)	879482
16	Front panel sticker, M-NIBP (Fre)	880159
16	Front panel sticker, M-NIBP (Ger)	880476
17	LED board, M-NIBP	880361
18	Hose connector	64654
1	Module box (wide)	886168
3	Latch	879181
2	Spring pin	879182
5	Cross recess screw M3x8 black	628706
10	Cross cylinder-head screw M3x10	628703
9	Cross cylinder-head screw M3x20	628709
19	Cross cylinder-head screw M2.5x6	628700



## Rev. 02

<u>Item</u>	<u>Item description</u>	<u>Order No.</u>
8	NIBP board, M-NIBP (Rev. 02)	*(882418) Use 883011 <sup>1)</sup> 883902
23	Check valve	58542

## Rev. 03

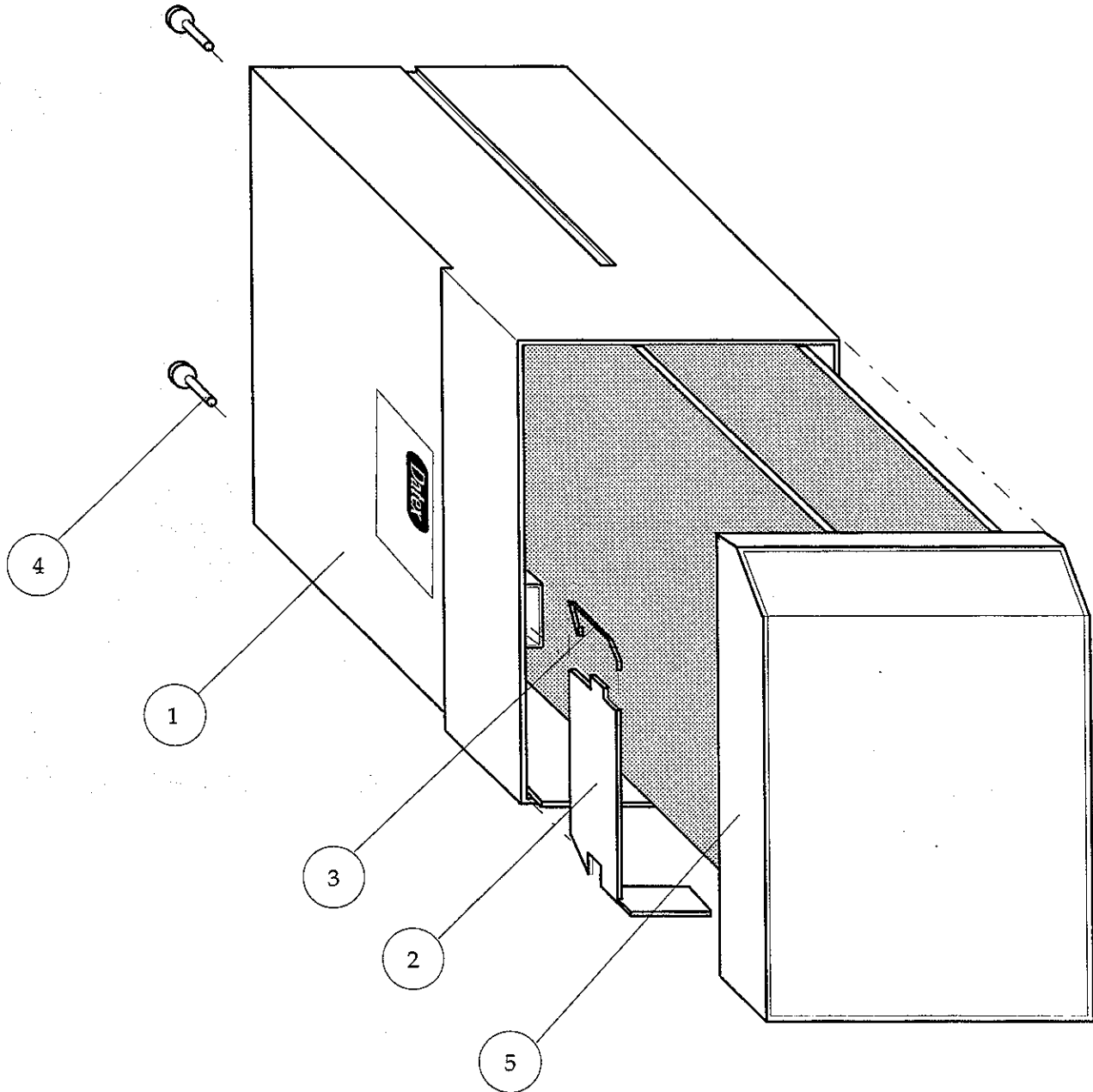
<u>Item</u>	<u>Item description</u>	<u>Order No.</u>
8	NIBP board, M-NIBP (Rev. 03)	*883011
	NIBP software	*883902
14	NIBP pump, M-NIBP (Rev. 03)	*883346
16	Front panel sticker, M-NIBP (Spa)	884386
16	Front panel sticker, M-NIBP (Swe)	885870
16	Front panel sticker, M-NIBP (Dut)	886124
16	Front panel sticker, M-NIBP (Ita)	886752
16	Front panel sticker, M-NIBP (Fin)	888872

The front panel unit includes all the connectors and input boards.

\* = the part is recommended for stock

<sup>1)</sup> The NIBP board 883011 can be used as a replacement only with NIBP software 883902.

## **6.2 Exploded View of Module**



**Figure 3 Exploded View of Module Box**

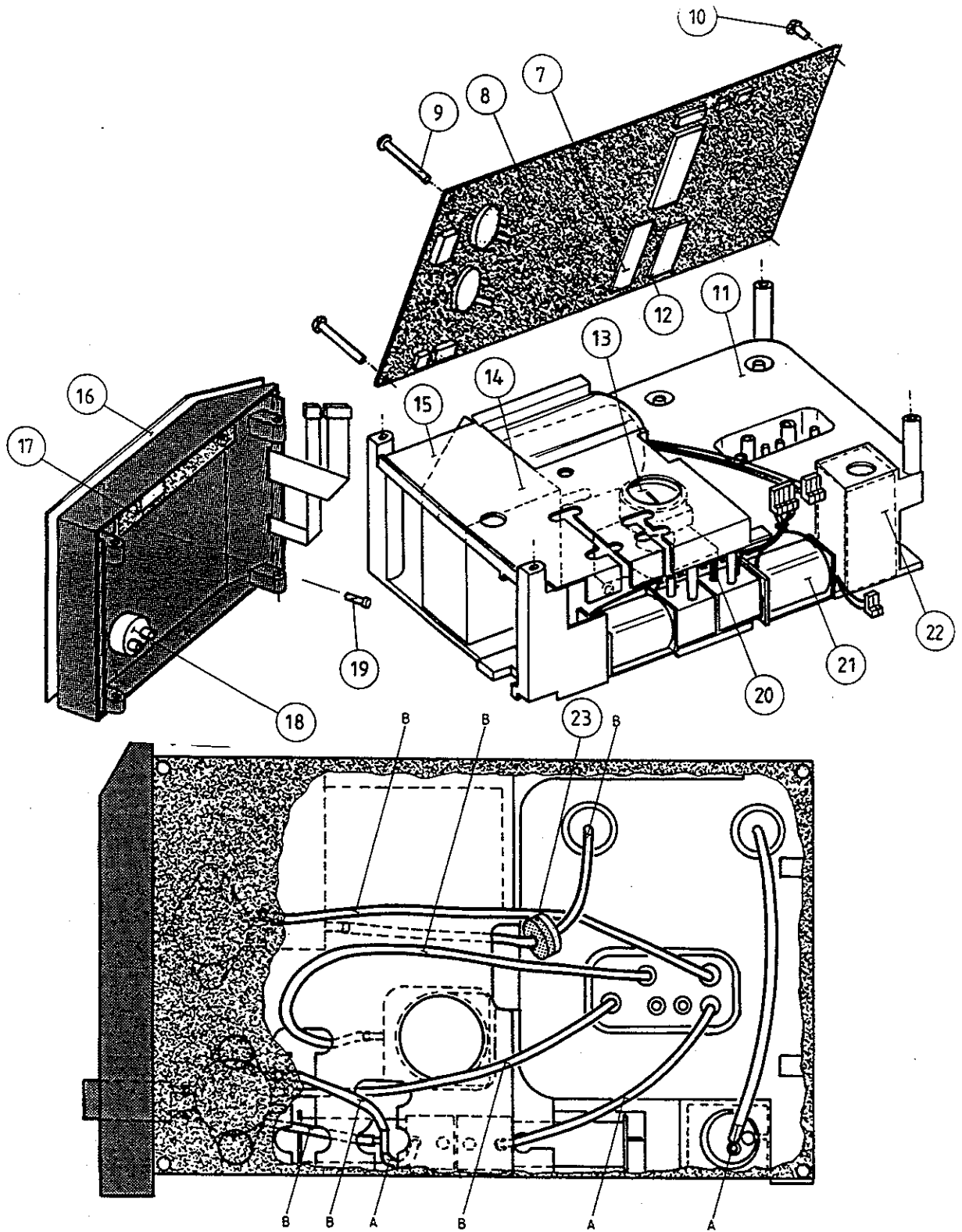


Figure 4 Exploded View of NIBP Module

A = 73373 / 1,7  
B = 73375 / 3,18 x 6,35

## **7. EARLIER REVISIONS**

For service information on the earlier revisions, please refer to:

NIBP Module revision 01      Service Manual p/n 880850

NIBP Module revision 02      Service Manual p/n 882580

## **Recorder Module, M-REC (Rev. 02)**

All specifications subject to change without notice

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## **INTRODUCTION**

The AS/3 Recorder Module, M-REC, and the built-in Recorder, of the AS/3 Compact Monitor, F-CMREC, provide real time printing of waveform and numerical data, and also trend data.

The Recorder module and the built-in Recorder are technically the same, the only difference is that the M-REC is placed in a module box, and the F-CMREC is placed in the AS/3 Compact Monitor frame. In the following they both are referred to as the recorder.

### **NOTES:**

- \* Printings on thermal paper may be destroyed when exposed to light, heat, alcohol etc. Take a photocopy for archive.
- \* The Recorder module cannot be used in the Extension Frame, F-EXT4.

## **I SPECIFICATIONS**

Module size	75 x 180 x 112 mm
W x D x H	3.0 x 7.1 x 4.4 in
Module weight	0.9 kg/ 2 lbs
Power consumption	3 W
Principle	Thermal array
Print resolution:	
Vertical	8 dots/mm (200 dots/inch)
Horizontal	32 dots/mm (800 dots/inch) at speed of 25 mm/s and slower
Paper width	50 mm, printing width 48 mm
Traces	Selectable 1, 2, or 3 traces
Print speed	1, 6.25, 12.5, 25 mm/s

## **2 FUNCTIONAL DESCRIPTION**

### **2.1 Recorder Board**

#### **In general**

The task of the Recorder board inside the Recorder is to connect it to the module bus. Additionally, three front panel keys are connected through the board to the recorder.

In the module the recorder and the Recorder board are connected together with a small connector board and 12-pin flex-strip cable.

#### **External communication**

Communication with the host processor takes place in +5 V CMOS-level serial communication B-channel and with RS485-reset.

#### **Reset**

Differential RS485-reset from the module bus is transferred to mod-bus-reset signal in the board. Besides, the board has its own power-up-reset, whose time constant is about 0.1 seconds. The RESET-signal is active when either the mod-bus-reset or the power-up-reset is active.

#### **+5 V priority**

The recorder supply voltage of +15 VREC is switched on after +5 V is present.

#### **Front panel keys**

The recorder can read up to three keys and pass their status on to the host processor in serial communication.

For protecting the key switch signals from static discharges, there are zener diodes and series resistance option. Pull-up resistor is not needed because there are pull-up resistors connecting the key switch signal inputs and +5 V together inside the recorder.

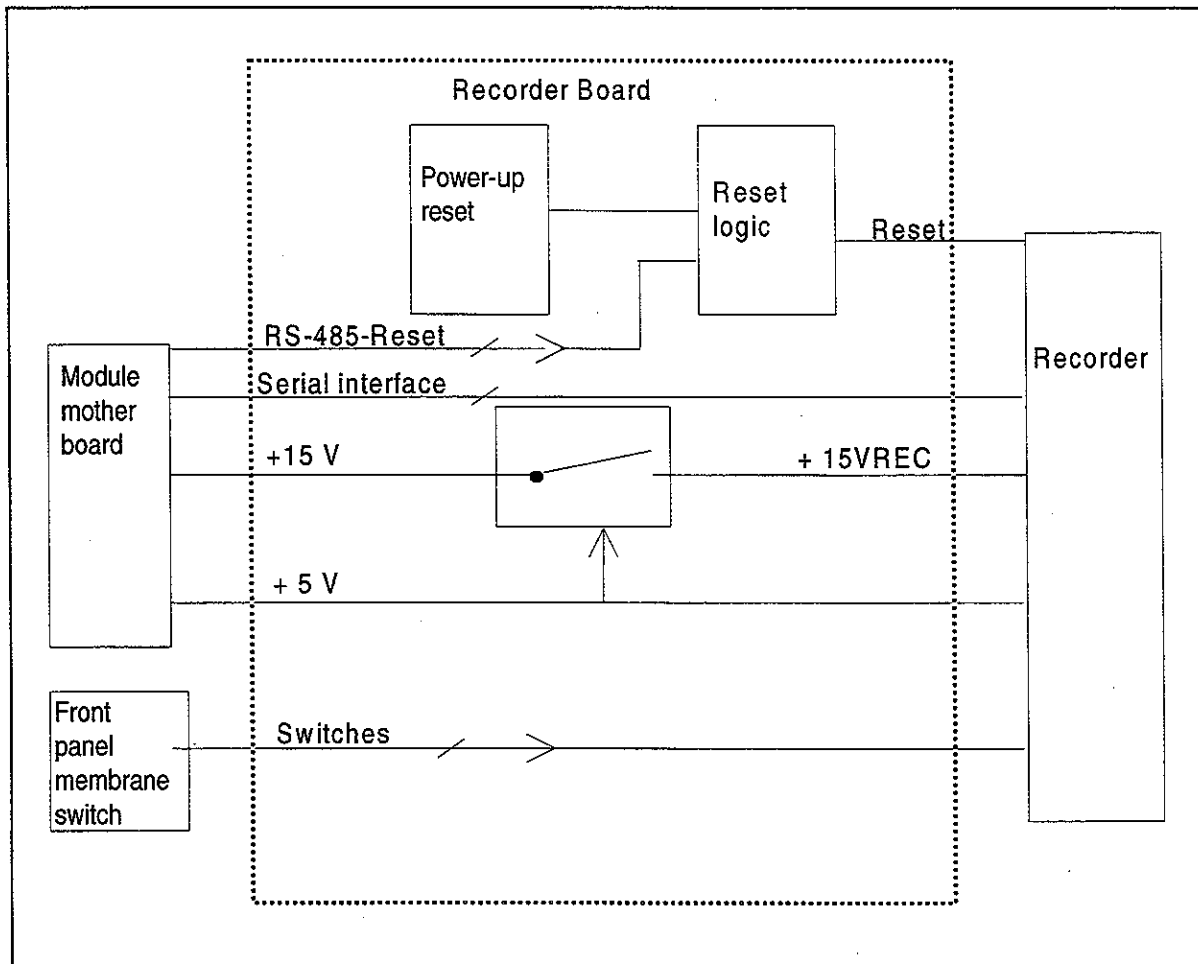


Figure 1 Recorder Board Block Diagram

## 2.2 Module Bus Connector Configuration

Rear panel 25-pin female D-connector in the M-REC

Pin No	I/O	Signal
1	I	RESET_RS485
2		Not connected
3	I	+15 VDIRTY*
4		Not connected
5		Not connected
6		Not connected
7		Ground & Shield
8	I	-RESET_RS485
9	O	CTSB
10	I	RTSB
11	O	RXDB
12	I	TXDB
13		Ground & Shield
14		Not connected
15	I	GroundDIRTY
16		Not connected
17		Not connected
18		Not connected
19		Not connected
20		Not connected
21		Not connected
22		Not connected
23		Not connected
24	I	+5 VDC
25	I	+5 VDC

I = in, O = out of the Recorder

## **3 SERVICE PROCEDURES**

### **3.1 General Service Information**

Usually field service of the Recorder is limited to replacing the faulty circuit boards or mechanical parts. The boards are then returned to Datex-Engstrom for repair.

Datex-Engstrom is always available for service advice. Please provide the unit serial number, full type designation, and a detailed fault description.

**CAUTION:** Only trained personnel with appropriate equipment shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

### 3.2 Preventive Maintenance Checks

Perform these checks after any service and at least once a year to keep the Recorder in good condition.

#### 1. Visual inspection of the module

- : If the module is disassembled, check that grounding wires and all connectors are properly connected and there is no loose object inside the module before attaching the module box.

#### 2. Functional checks (for F-CMREC only steps that are applicable)

- : Insert the module into Frame where there is at least ESTP/EST/ETP module. Turn the power on. No error message appears.
- : Check the functions of the Record Wave and Stop keys.
- : Pull out the module. Reinsert the module while the power is still on. Check the functions of the Record Wave and Stop keys again.
- : Press Recorder and Recorder Setup keys. Choose 20 seconds as recording length and 6.25 mm/s as paper speed. Start printing by Record Wave key. The length of printout should be  $12.5 \pm 1$  cm.
- : Change paper speed to 12.5. The length should be  $37.5 \pm 3$  cm.
- : Change paper speed to 25. The length should be  $75 \pm 6$  cm.
- : Press Recorder key and set up the following with the ComWheel:

Waveform 1	ECG1
Waveform 2	OFF
Waveform 3	OFF

Press Record Wave key. The printout should fill the paper and lines should be unbroken.

### **3.3 Disassembly and Reassembly**

Disassemble the Recorder module in the following way. See the exploded view of the module:

- a) Remove the two screws from the back of the module.
- b) Pull the module box slowly rearward and detach it from main body. Be careful with loose latch and spring pin for locking.
- c) Open paper loading hatch of the recorder. With a long blade screwdriver loosen the two screws at the bottom of the recorder housing.
- d) Disconnect 50-pin connector from the back of the recorder and 5-pin ribbon connector of keypad from the Recorder board.

Now the recorder and front panel frame can be pulled out of the main body. The front panel frame is slipped out of the recorder by pulling rearward.

The Recorder board is attached to the metal chassis with four screws.

**CAUTION:** In the M-REC the Recorder board is fixed to the metal chassis at the factory in a position that gives best contact of the D-connectors. The board and the chassis must not be separated.

Before disassembling the F-CMREC the AS/3 Compact Monitor Frame must be opened, see the corresponding service manual.



## 4 TROUBLESHOOTING

### 4.1 Troubleshooting chart

PROBLEM	CAUSE	TREATMENT
Module not responding to front panel keys, but operates through Recorder menu.	Membrane switch cable loose or broken.	Check the cable. Replace the front panel if necessary.
	M-REC: Flex-strip cable broken.	Check the cable. Replace if necessary.
	M-REC: Bad contact on connector board.	Check contact.
Recorder will not start. No error messages shown.	M-REC: Module not properly inserted.	Reinsert the Module properly.
	M-REC: Flex-strip cable broken.	Check the cable. Replace if necessary.
	M-REC: Connector board loose.	Check connector board connections.
	Recorder board faulty.	Replace the board.
	Recorder faulty.	Replace the Recorder.
Recorder works but nothing appears on the paper.	Active side of the paper downwards.*	Turn the paper roll.
	Recorder faulty.	Replace the Recorder.

\*

To test which side is active: Place the paper on a hard surface and draw a line with a finger nail. On the active (thermal) side appears a dark line.

## 4.2 Messages

MESSAGE	EXPLANATION
Recorder: out of paper	Release paper jam or insert a roll of paper into the recorder.
Recorder: cover open	Close the recorder cover correctly.
Recorder: thermal array overheat	Recorder overheated. Stop using and cool it down.
Recorder: input voltage low	+15 Vrec is too low. Check flex-strip cable and connector board.
Recorder: input voltage high	+15 Vrec is too high. Check flex-strip cable and connector board.
Recorder system error 1, 2, 3	System error. Remove the Recorder Module and reinsert it.
Recorder: module removed	Insert the Recorder Module into the Central Unit.

## **5 SERVICE MENU**

There is no service menu for the Recorder module.

## 6 SPARE PARTS

### 6.1 Spare Parts List

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

NOTE: Accessories are listed in the booklet AS/3 Supplies and Accessories.

Item numbers refer to the exploded view in chapter 6.2.

#### Recorder Module, M-REC

##### Rev. 00

<u>Item</u>	<u>Item description</u>	<u>Order No.</u>
6	Recorder board, M-REC (Rev.00)	*(880313) Use 883384
7	Recorder	*90350
8	50-pin connector cable, M-REC	879362
4	Front panel unit, M-REC	881328
	Membrane keypad	879372
10	Front panel sticker, M-REC (Eng)	879483
10	Front panel sticker, M-REC (Ger)	880486
10	Front panel sticker, M-REC (Fre)	880172
1	Module box (wide)	886168
3	Latch	879181
2	Spring pin	879182
9	Metal chassis	(879179) Use 883384
5	Cross recess screw M3x8 black	616215

##### Rev. 01

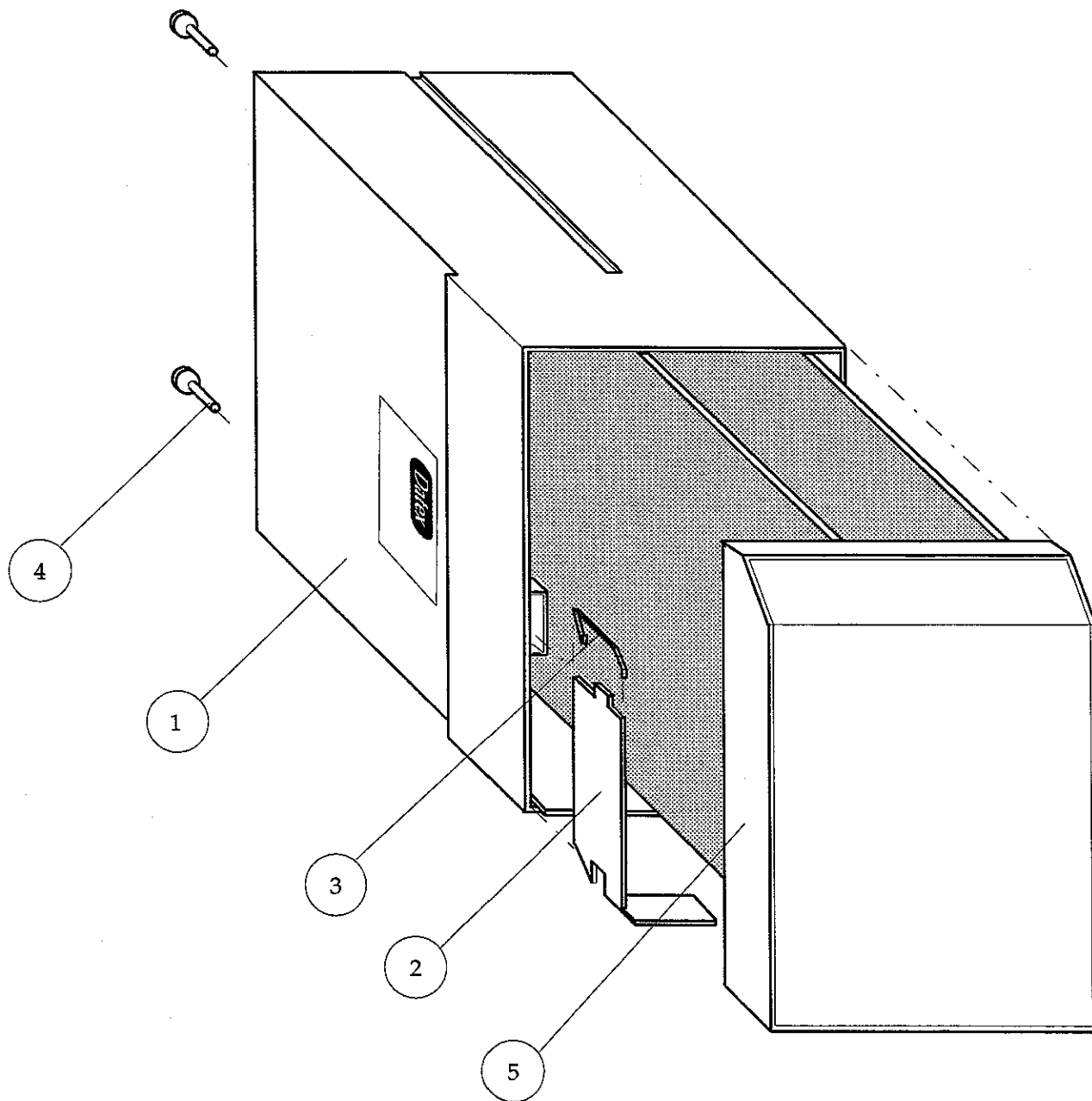
<u>Item</u>	<u>Item description</u>	<u>Order No.</u>
9 883384	Metal chassis with recorder board	*(881964) Use

**Rev. 02**

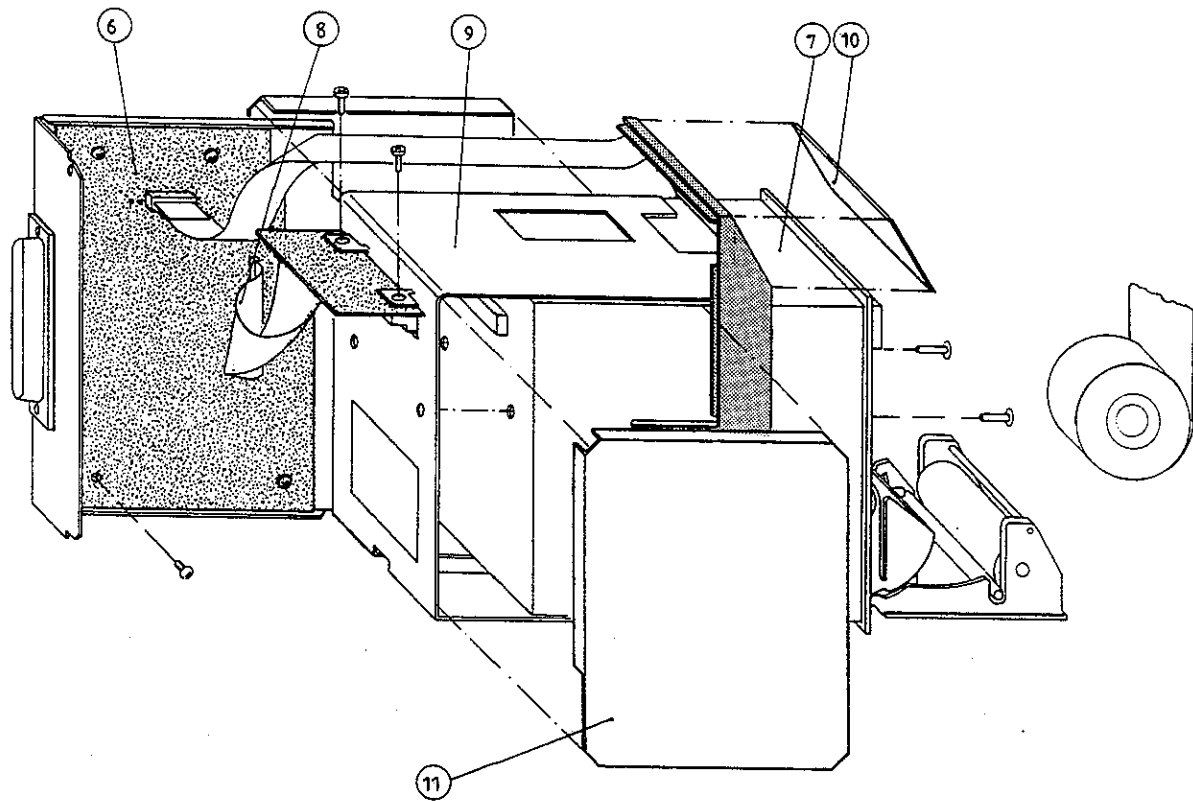
<u>Item</u>	<u>Item description</u>	<u>Order No.</u>
9	Metal chassis with recorder board	*883384
11	Metal cover plate, M-REC	885292
10	Front panel sticker, M-REC (Spa)	884388
10	Front panel sticker, M-REC (Swe)	885869
10	Front panel sticker, M-REC (Dut)	886066
10	Front panel sticker, M-REC (Ita)	886761
10	Front panel sticker, M-REC (Fin)	888875

\* = the part is recommended for stock

## **6.2 Exploded View of Module**



**Figure 2** Exploded View of Module Box



**Figure 3    Exploded View of Recorder Module**

## **7 EARLIER REVISIONS**

For service information on the earlier revisions, please refer to:

Recorder Module revision 00      Service Manual p/n 880850

Recorder Module revision 01      Service Manual p/n 882580